Aug. 24, 1948. W. W. MUIR 2,447,592

INTERNAL-COMBUSTION ENGINE COOLING SYSTEM

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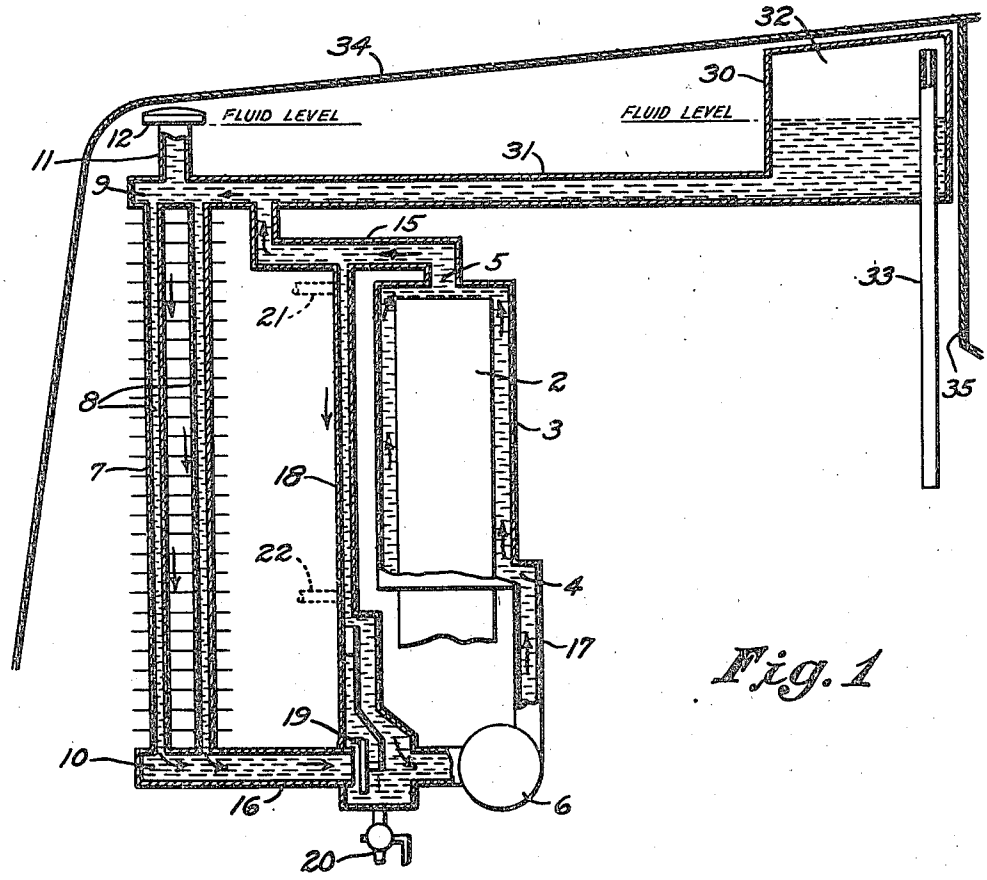


Fig. 1

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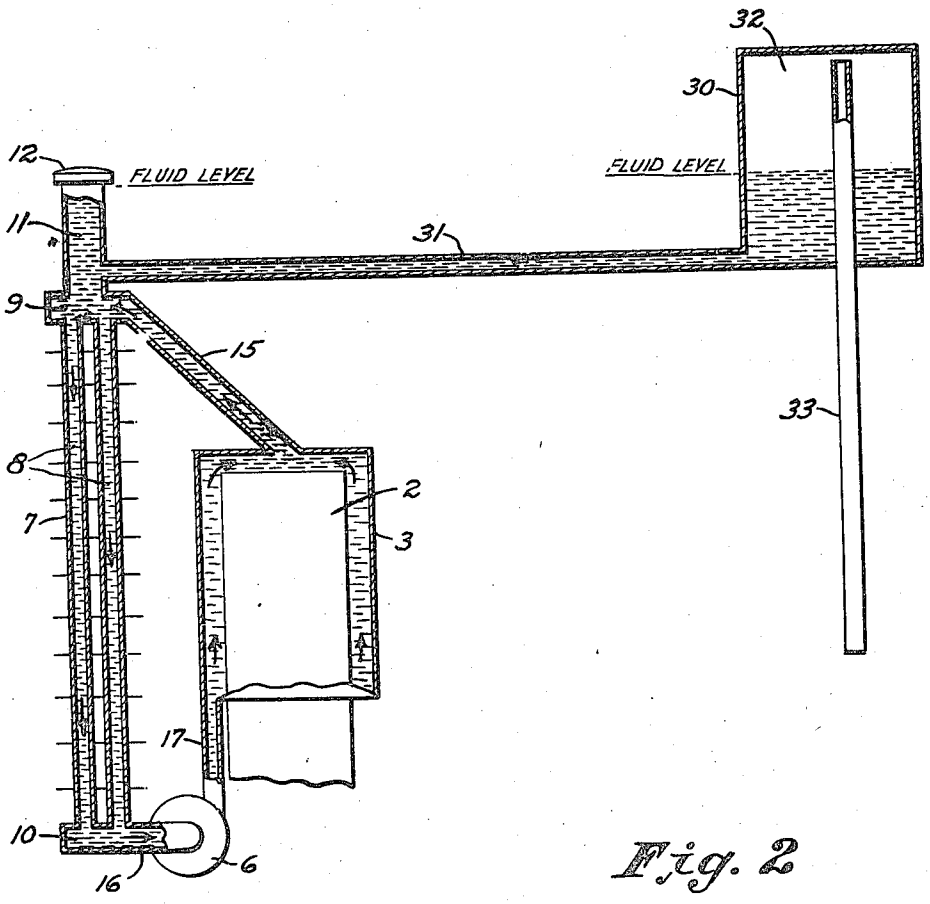


Fig. 2

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INTERNAL-COMBUSTION ENGINE COOLING SYSTEM

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17 Claims. (Cl. 123—178)

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This invention relates to cooling systems for internal combustion engines and the like, having for its object to provide a construction and a method which are more efficient in operation than those heretofore proposed.

With these and other objects in view the invention resides in the novel details of construction and combinations of parts constituting the apparatus, as well as in the novel steps and combinations of steps constituting the method of cooling, all as will be disclosed more fully hereinafter and particularly covered by the claims.

Referring to the accompanying drawings forming a part of this specification, and in which like numerals designate like parts in all the views—

Fig. 1 is a diagrammatic representation in cross section of a cooling system made in accordance with this invention; and

Fig. 2 is a similar diagram of a modification of the system shown in Fig. 1.

Cooling systems for internal combustion engines operate most satisfactorily if the average temperature of the cooling fluid is maintained between 180° and 190° F. in the passage from the engine jacket to the radiator, it being understood that with such average temperature, a part of the fluid will have a temperature at or slightly above 212° F. as in the immediate locality of the engine jacket, whereupon vapor or steam is generated. Inasmuch as the density of such vapor or steam is less than the density of the fluid at 180°, the vapor will become separated from the denser fluid in the upper portion of the radiator and become lost from the system more or less continuously through the usual air vent heretofore provided in cooling systems. Consequently there is a continual diminution of the quantity of cooling fluid in the system, and an increase in the amount of vapor and/or steam formed.

From the time a new radiator is placed in operation, the efficiency of the cooling core thereof rapidly declines, due to the formation of scale and sludge in the small fluid passages of the cooling core, it not being uncommon that the cooling core will lose up to 80% of its cooling efficiency in a short period of time, and necessitate frequent radiator flushings with a cleansing solution. This formation of scale and sludge in said passages is due to loss of the cooling fluid through evaporation. Evaporation is caused by lack of uniform temperature and density of the cooling fluid that comes in contact with the air in the upper portion of the radiator, and it is also caused by turbulence and high temperature of part of the cooling fluid

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in that area. The lack of uniform temperature in the passage from the engine jacket to the radiator, is due to lack of uniform circulation of the cooling fluid through the jacket as well as lack of uniform temperature of the metal of said jacket. The contact of the hot cooling fluid, and particularly the vapors therefrom, with the air in the radiator is responsible for oxidation of the metal and the formation of the scale and sludge.

The purpose of this invention is to overcome these defects in the efficiency of a cooling system, and to provide a system which will remain free thereof throughout all conditions of engine operation. This is principally attained by providing a gravity sealed, liquid system incapable of producing or permitting the oxidation which results in formation of scale and sludge, and also is attained by causing relatively immediate condensation of any vapors which may form, so that said vapors do not have the chance of creating the oxidizing condition above referred to.

In the drawings an engine cylinder is indicated at 2 provided with a jacket 3 having an inlet at 4 and an outlet at 5 for the cooling fluid which is maintained in circulation through the jacket during the operation of the engine as by the pump 6. A radiator of the down-flow type is generally identified by the numeral 7 and comprises a plurality of vertically disposed tubes such as 8 formed of relatively thin metal and of relatively small diameter, as is well known in this art. The upper ends of these tubes are interconnected by a manifold 9, and the lower ends of said tubes are similarly interconnected by another manifold 10, but it is to be understood that these manifolds are not of the nature of tanks as found in heretofore known down-flow radiator constructions. A filler pipe 11, having an air-tight screw cap 12 associated therewith, communicates with the upper manifold, and it is by means of said filler pipe that the cooling system is supplied with the cooling medium.

The outlet 5 of the engine jacket is connected as by the conduit 15 with the upper manifold 9, and the lower manifold 10 is connected as by the conduit 16, pump 6, and conduit 17, with the inlet 4 of the engine jacket, thereby establishing the cooling circuit. In other words the pump 6 draws the cooling fluid from the conduit 16 and forces the same through conduit 17, jacket 3, conduit 15, upper manifold 9, radiator tubes 8, and lower manifold 10 back to the conduit 16, all as indicated by the arrows.

For automatic control of such circuit, a by-pass conduit 18 may be provided directly between con-

duits 15 and 16, said by-pass having therein a thermostatically controlled valve 19 for stopping the flow of fluid from conduit 16 to the pump, thereby cutting off the cooling effect of the radiator 7. Hence, when the engine is started in cold weather, this thermostatic valve will be closed wherefore the circuit for the cooling fluid will comprise merely the engine jacket and the by-pass conduit 18, but as the temperature of the cooling fluid increases, the thermostatic element of the valve 19 will be affected by this rise in temperature, and will cause said valve to open, thus permitting the pump 6 to draw fluid from the radiator by means of conduit 16 and hence subject the heated cooling fluid to the cooling action of said radiator. A drain cock 20 is provided at the lowest point of the system.

If a car heater is to be operated by the heated cooling medium, the same may be connected to the cooling system as by the pipe connections indicated in dotted lines at 21 and 22 to the by-pass conduit 16, or any other desired part of the system.

In order to maintain this system liquid sealed, there is provided a tank or reservoir 30 the bottom of which is connected as by the unrestricted conduit 31 to the upper manifold 9, this conduit being devoid of any valve or other restriction, and preferably being of relatively small internal diameter, such for example as ¼ inch for the usual automobile cooling system. This tank is so disposed that when the system is completely filled with fluid through the filler pipe 11, the fluid level in the tank will be approximately as shown in the drawings, leaving an air chamber 32 above such level and which air chamber is vented to the atmosphere as by the vent pipe 33. That is to say, the tank has no filler opening or, stated in other words, it is a normally closed tank into which the fluid is passed by virtue of the filler pipe 11 and conduit 31, the fluid rising in said tank until the level thereof corresponds to the level of the filler pipe, air escaping from the tank through the vent 33. In Fig. 1 the conduit 15 is illustrated as joining the conduit 31 at the upper manifold 9. The bottom of the tank 30 may be in the same horizontal plane with the upper manifold 9, or slightly elevated with respect thereto, but in no instance should it be below said manifold. It is the reservoir of fluid in said tank which operates under the law of gravity to maintain the system liquid-sealed under all conditions of engine operation.

Thus it will be understood that the system when filled with fluid will be a completely closed system, with the fluid disposed therein and in the tank 30 up to the level created by the upper end of the filler pipe 11, whereupon no air will be in the system, but there will be air in the upper portion of tank 30 above said fluid level. As the engine is operated, the temperature of the cooling fluid will rise, the fluid first being circulated mechanically by the pump through only the by-pass conduit 18 and then, at higher temperatures, additionally through the radiator 7 when the thermostatic control is employed. This circuit will never include the tank 30 and the fluid therein, nor will it include the fluid in conduit 31 between said tank and its juncture with conduit 15. It thus results that the temperature of the fluid in conduit 31 and tank 30 is but slightly affected by the temperature rise in the true cooling circuit, or in other words there will always be a relatively large differential of temperature between

the fluid of the circuit and the fluid of the tank 30.

Upon higher temperatures being attained, vapors and/or steam may be generated in the cooling circuit in the locality of the jacket 3, which vapors will rise and pass in circuit to the juncture of conduits 15 and 31. If the flow of the cooling fluid in the cooling circuit remains substantially constant, the pressure in manifold 9 and conduit 31 will be equal in magnitude, and there will be no flow of fluid or vapor from manifold 9 to conduit 31. The flow of fluid and vapor will be from manifold 9 to tubes 8, by virtue of the pump 6.

On the other hand, if the flow of cooling fluid in the cooling circuit is abruptly reduced when the power output from the engine is high, vapor pockets will form in jacket 3 and displace part of the cooling fluid. The displaced cooling fluid will cause the pressure in manifold 9 to increase above the pressure in conduit 31, and this difference in pressure will cause fluid and vapor to flow from manifold 9 to conduit 31 and the reservoir 30. The duration of this flow will vary from thirty-one seconds to two minutes in time. When this flow from manifold 9 to conduit 31 has subsided, the flow will be reversed i. e. from reservoir 30 to manifold 9 in order to replace the fluid which was displaced by the vapor pockets in jacket 3. The formation of vapor pockets in jacket 3 when the flow of cooling fluid is abruptly reduced, is caused by the lag in heat transfer from the engine cylinder 2 to the cooling fluid in jacket 3, and this lag will vary from thirty-one seconds to two minutes, depending upon a number of variable conditions. Therefore it is to be understood that the reservoir 30 acts as a surge absorber and a vapor condenser.

Obviously if the engine is abruptly stopped, when the power output therefrom is high, the surge in the cooling system will be greater than if the flow in the cooling circuit was abruptly reduced. When the surge occurs, the temperature of the fluid in the reservoir will increase, and at the same time the volume of fluid in the reservoir will increase. When the surge subsides the temperature of the fluid in the reservoir will decline, and also the volume of the fluid in the reservoir will become reduced.

If the flow of cooling fluid in the cooling circuit remains substantially constant, and the radiation from radiator 7 to the air remains substantially constant, all of the vapor in conduit 15 and manifold 9 will be condensed in the radiator tubes 8. The only time that vapor will flow from the manifold to the conduit 31 is when a surge occurs in the cooling system. Inasmuch as this system is a liquid gravity sealed cooling circuit, its operation is different from the down-flow system where free air is present in the upper part of the top tank on the radiator. The volume of the fluid in tank 30 is infinitely greater than the volume in filler pipe 11, wherefore there is little or no danger of the fluid level ever becoming lowered accidentally to the plane of conduit 31.

The cover over the automobile engine, commonly referred to as the hood, is represented at 34, and 35 designates the vertical partition extending downwardly from the hood to form the cowl. The tank 30 may be provided with a top opening, or a covered opening at the bottom thereof, to provide for cleaning the tank as and when necessary.

The same principles are present in the modification illustrated in Fig. 2, the difference resid-

ing only in structural details. Here the conduit 31 from the tank 30 is shown joining the filler pipe 11 at a point just above the upper manifold 9, the conduit 15 passing directly from the engine jacket 3 to said manifold, and the thermostatic valve, by-pass conduit and drain cock have been omitted from Fig. 2 to reduce the invention to its simplest form of illustration.

It is obvious that those skilled in the art may vary the details of construction and arrangements of parts constituting the apparatus, as well as vary the steps and combinations of steps constituting the method of cooling without departing from the spirit of this invention wherefore it is desired not to be limited to the exact foregoing disclosure except as may be required by the claims.

What is claimed is:

1. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a downflow radiator, a pump, and fluid-conducting connections between said jacket, said radiator and said pump for establishing a cooling circuit, a tank for cooling fluid maintained at a level above the cooling circuit and connected to the circuit to provide free gravity feed of the fluid in said tank to the circuit, and means for filling the circuit and a portion of said tank at a point remote from said tank.

2. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a downflow radiator, a pump, and a fluid-conducting connection between said jacket, said radiator and said pump for establishing a cooling circuit, a tank for cooling fluid maintained at a level above the cooling circuit, a fluid-conducting conduit connecting said tank and the circuit to provide gravity feed of the fluid in said tank to the circuit, means for venting the system at the coldest portion thereof, said means including a portion of said conduit, and means for filling the circuit and a portion of said tank at a point remote from said tank.

3. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a downflow radiator, a pump, and fluid-conducting connections between said jacket, said radiator and said pump for establishing a cooling circuit, a tank for cooling fluid maintained at a level above the cooling circuit, a vent for the system connected to the coldest portion of said tank, a fluid-conducting conduit connecting said tank and the circuit, said conduit serving to conduct vapors travelling toward said vent as well as serving as a gravity feed for the fluid flowing from said tank to the circuit, and means for filling the circuit and a portion of said tank at a point remote from said tank.

4. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a downflow radiator, a pump, and fluid conducting connections between said jacket, said radiator and said pump for establishing a cooling circuit, a tank for cooling fluid maintained at a level above the cooling circuit, a vent for the system connected to the coldest portion of said tank, a fluid conducting conduit connecting said tank and the circuit, said conduit serving to conduct vapors travelling toward said vent as well as serving as a gravity feed for the fluid flowing from said tank to the circuit, and means for filling the circuit and a portion of said tank.

5. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a downflow radiator, a pump, and fluid conducting connections between said jacket, said radiator and said pump for establishing a cooling circuit, a tank for cooling fluid maintained at a level above the cooling circuit and connected to the hot side of the circuit to provide free gravity feed of the fluid in said tank to the circuit, and means for filling the circuit and a portion of said tank at a point remote from said tank.

6. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a radiator and fluid-conducting connections between said jacket and said radiator for establishing a cooling circuit, a reservoir of cooling fluid delivering to the hot side of the circuit, and means for venting the system at the coldest portion thereof.

7. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a radiator and fluid-conducting connections between said jacket and said radiator for establishing a cooling circuit, a reservoir of cooling fluid for the circuit, and a conduit between an upper portion of said radiator and said reservoir, said conduit serving as a free gravity feed for the fluid from the reservoir to the circuit, as well as serving to conduct vapors from the circuit to said reservoir for condensation therein.

8. A cooling system for an internal combustion engine provided with a cooling jacket, comprising a radiator and fluid-conducting connections between said jacket and said radiator for establishing a cooling circuit, a reservoir of cooling fluid for the circuit, and a conduit between an upper portion of said radiator and said reservoir, said conduit serving as a gravity feed for the fluid from the reservoir to the circuit, as well as serving to conduct vapors from the circuit to said reservoir for condensation therein, and means for venting the system at the coldest portion thereof.

9. In a cooling system for an internal combustion engine provided with a cooling circuit for the cooling fluid, the combination of a tank for holding a quantity of the cooling fluid, said tank disposed above the cooling circuit and having a single unrestricted conduit leading from the bottom portion of the tank to the upper portion of the circuit for conducting cooling fluid in one direction and vapors in the opposite direction.

10. In a cooling system for an internal combustion engine provided with a cooling circuit for the cooling fluid, the combination of a tank for holding a quantity of the cooling fluid, said tank disposed above the cooling circuit and having a single conduit leading from the bottom portion of the tank to the upper portion of the circuit for conducting cooling fluid in one direction and vapors in the opposite direction, and means for venting the system at the coldest portion thereof.

11. The method of cooling an internal combustion engine provided with a cooling circuit through which a cooling fluid may be circulated, which comprises establishing a reservoir of the cooling fluid, conducting the cooling fluid from such reservoir to the hot side of the circuit, and subjecting all vapors formed in the circuit to the action of the conducted fluid for condensation thereof.

12. A method of cooling an internal combustion engine provided with a cooling circuit through which a cooling fluid may be circulated, which comprises establishing a reservor of the cooling fluid, conducting the cooling fluid from such

reservoir to the hot side of the circuit, subjecting vapors formed in the circuit to the action of the conducted fluid for condensation thereof, and venting the system at the coldest portion thereof.

13. The method of cooling an internal combustion engine provided with a jacket which comprises creating a cooling circuit for a cooling fluid through such jacket, establishing a reservoir of the cooling fluid, conducting the fluid from such reservoir to the upper portion of the circuit, and causing all vapors formed in the circuit to be condensed by contact with the conducted fluid.

14. The method of cooling an internal combustion engine provided with a jacket which comprises creating a cooling circuit for a cooling fluid through such jacket, establishing a reservoir of the cooling fluid, conducting the fluid from such reservoir to the upper portion of the circuit, causing all vapors formed in the circuit to be condensed by contact with the conducted fluid, and maintaining the fluid in such reservoir at a temperature much lower than the operating temperature of the fluid in such circuit.

15. The method of cooling an internal combustion engine provided with a jacket which comprises creating a cooling circuit for a cooling fluid through such jacket, establishing a reservoir of the cooling fluid, conducting the fluid from such reservoir to the upper portion of the circuit, causing vapors formed in the circuit to be condensed by contact with the conducted fluid, maintaining the fluid in such reservoir at a temperature much lower than the operating temperature of the fluid in such circuit, and venting the cooling system at the coldest portion thereof.

16. A cooling system for an internal combustion engine having a cooling circuit comprising a down-flow radiator and a reservoir of cooling fluid disposed at a level above said circuit, the reservoir connected at its bottom to the upper portion of said radiator by a substantially horizontal conduit, the system being vented at the coldest portion of the rservoir whereby any vapors formed in the circuit will be condensed in their passage through said conduit in contact with the cooling fluid therein.

17. An all-liquid cooling system for an internal combustion engine provided with a cooling jacket, comprising a radiator and liquid-conducting connections between said jacket and said radiator for establishing a cooling circuit, and a reservoir of liquid delivering unrestrictedly to the hot side of the cooling circuit.

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